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ABSTRACT

The following research questions were addressed in this study to investigate elementary school teachers' (N=236) attributional styles related to their teaching methods and allocation of time: (1) How do teachers attribute the causes of success or failure in their science teaching; (2) Does the attributional model help explain science teaching performance; and (3) Are the attributional variables predictors of science teaching performance? Data were collected using four instruments to provide information on teacher background, knowledge of science content, causal attributions/dimensions, and choice of teaching role. Results, among others, suggest that in successful teaching situations, teachers tend to make attributions to internal causes and in failure situations to external causes, that is, elementary school teachers have distinct attributional styles for explaining success or failure in science teaching; two antecedents (perception of past teaching success and knowledge of science content) are related to teachers' causal attributions and causal effects; the number of methods courses completed related to causal effects (enjoyment and expectancy shift) and science teaching performance (time allocation and teaching method) but not to their causal attributions; and that enjoyment of science teaching was associated with increased allocation of time to each science. (JN)

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THE PREDICTORS OF SCIENCE TEACHING PERFORMANCE IN ELEMENTARY SCHOOL TEACHERS

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of

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The Predictors of Science Teaching Performance in Elementary School Teachers

During the last two decades concern for the level of science elementary instruction has led to the development of federally funded curriculum materials for teaching science in the classroom. The new instructional materials call for a nondirective teaching style (Penick, Shymansky, Matthews, & Good, 1976) and involve children in firsthand experiences with science materials (Butts,1976). Thus, the new science instruction represents a departure from the traditional teacher-oriented methods which rely on reading, lecturing, and the memorization of facts. The new science teaching methods have had a positive effect on cognitive and affective learning (Bowyer & Linn, 1978; Lowery, Bowyer, & Padilla, 1980), and on the classroom behavior of children (Good, Matthews, Shymansky, & Penick, 1976). However, despite the educational advantages of the new teaching strategies, textbook reading continues to be the most frequently used instructional method for teaching science (Helgeson, Blosser, & Howe, 1977).

According to Shulman (1979) research in science teaching has been less concerned with the amount of time teachers allocate to science in the elementary curriculum. Harnischfeger and Wiley (1976) report that nowadays teachers have great flexibility in allocating their own time in the classroom. Indeed, wide differences appear to exist in teachers' allocation of time (Fisher, Marliave, Filby, Cahen, Moore, & Berliner, 1976). For example, Vinci (1965) found that some elementary school teachers indicated that they spend over 90 minutes per week teaching science while others said that they allocate no time to science at all. Variance in time allocation is an important area for investigation because it appears to be related to differences in pupil achievement (Clark & Yinger, Note 1; Dahloff, 1971).

The present study sought to identify factors that contribute to choice

of teaching method and persistence in allocating time to teaching science.

Many educators are turning to social psychological variables to help them understand classroom behaviors (Frieze, et al. Note 2). One set of variables that has increased the understanding of behavior in an academic setting includes individuals' perceptions of why they succeed or fail in a particular situation. Research has shown that attributions people make for the causes of their success or failure are important in predicting subsequent behavior at a similar task. These theoretical variables are called the Attributional Model of Achievement Motivation by Weiner and his associates. (Weiner, Russel, & Lerman, 1978) (See Table 1).

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Place Table 1 about here

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The attributional model has been applied extensively in educational contexts because it is a powerful tool for explaining choice and persistence of behavior. Many studies have demonstrated a link between students' academic performance and their perception of causality (Arkin & Maruyama, 1979; Bailey, Gladstone, & Helm, 1975; Diener & Dweck, 1978; Frieze, et al. Note 2). Other investigations have utilized attribution theory to explain how teachers assign responsibility for learning achievement in the classroom (see e.g., Ames, 1975; Beckman, 1970, 1972; Brandt, Hayden, & Brophy, 1975; Cooper, 1975).. However, it appears that investigations of the attributional process that center on the teachers' causal beliefs about their own classroom performance appear to be missing from the literature.

Beginning with investigations by Weiner, et al. (1971), it has been consistently demonstrated that in achievement situations, perceptions about

the causes of success or failure called causal attributions, influence a variety of performance indicators such as speed, intensity, persistence, and choice (Weiner, 1974; Weiner & Sierad, 1975). Four causal attributions are most often used in explaining achievement-related outcomes. The individual (a) assesses his ability (b) estimates his effort expediture (c) considers the difficulty of the task, and (d) judges the magnitude and direction of luck. Weiner (1974) states that perceptions related to these four attributions are based on antecedents which include past experience as well as an array of other pertinent information. Causal attributions represent cognitive processes that mediate between these antecedents and a series of consequents (see Table 1).

According to Weiner (1979), the four causal attributions are classified along two causal dimensions, internal-external (internality) and stable-unstable (stability) (see Table 2). On the internality dimension, effort and ability are internal to the person whereas task difficulty and luck are external. On the

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Place Table 2 about here

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stability dimension, effort and luck which change over time are perceived as unstable, whereas task difficulty and ability which are constant over time, are perceived as stable. Causal dimensions influence two categories of causal effects, expectancy shifts and affective reactions (Weiner, 1974, 1976) (see Table 1). Expectancy shifts refer to whether or not success or failure is expected to recur if conditions remain the same. Weiner, Nierenberg, and Goldstein (1976) have confirmed earlier findings (Fontaine, 1974; McMahan, 1973) that the stability dimension of individuals' attributions affects their expectancy of success when a similar situation occurs in the future. Individuals who make attributions to unstable causes (effort and luck) tend to diminish the belief

that past outcomes will recur on subsequent trials.

Causal attributions and causal dimension appear to influence affective reactions, but the nature of this relationship is complex. The stability and internality of causal dimensions heighten affective responses (Weiner,1979). It also appears that a host of specific emotional reactions result from the different causal attributions, irrespective of their causal dimensions (Weiner,1977; Weiner, et al. 1978). In addition, Weiner et al. have found that individuals' general affective states might also be independent of their causal attributions and hinge only on outcome ("outcome-dependent" affects, p. 71).

Statement of the Problem

In the elementary school curriculum, science appears to be an instructional area in which many teachers feel inadequate about the task of teaching (Buccino, Dessart, Levine, & Rivkin, 1980). Perkes (1975) has concluded that teachers may avoid teaching science because they feel they will not be successful. Shrigley (1977) found that teachers attribute inadequate science teaching to a lack of materials, time, and skills. However, Hone (1970) has asserted that obstacles to effective science instruction such as the teacher's knowledge of science content and the availability of materials and time are within the teacher's control. Therefore, it appears that for many elementary science teachers, perceptions about their ability to master science content and feelings of inadequacy about their ability may influence the way they teach science. The present study investigated the relationship between teachers' causal cognitions and two aspects of their science teaching performance: persistence as measured by time allocation and choice of method.

In applying the attribution model to science teaching performance in elementary school teachers, the aim of this research was to investigate the following questions:

Question 1. How do elementary school teachers attribute the causes of success or failure in their science teaching?

Question 2. Does the Attributional Model of Achievement Motivation (Weiner,et al., 1978) help explain science teaching performance in elementary school teachers?

Question 3. Are the attributional variables predictors of science teaching methods and time allocation in elementary school teachers?

Variables

A. Independent variables. In the present study, factors derived from the attributional model served as the independent variables.

1. Antecedents: past experiences and individual biases.

(a) science background of the teacher -- extent of science education in high school, college, and graduate school, and the number of science teaching methods courses.

(b) knowledge of science content -- score on a standardized test of science content for elementary school teachers.

(c) perception of past science teaching -- teachers' evaluation of the degree to which their past science teaching has been successful.

2. Causal attributions: Teachers perceptions of the causes of the success or failure of their science teaching. The four causes that are used most often, ability, effort, task difficulty, and luck, were examined.

3. Causal dimensions: "second order" concepts (Weiner, et al., 1978) used by attribution theorists to organize the causal attributions along two dimensions, internality and stability. Scores for internality were derived by subtracting the scores for the external dimension (task difficulty and luck) from the scores for the internal dimension (ability and effort) for success and for failure. Similarly, scores for stability were derived by subtracting the scores

for the unstable dimension (effort and luck) from the scores for the stable dimension for success and for failure. No measurement items are required for causal dimensions. They are determined directly from causal attributions.

4. Causal effects: affective reactions and future expectancy.

(a) affective reactions -- measurement of the teachers' enjoyment of science teaching.

(b) expectancy shift -- teachers' expectancy for improvement in science teaching, measured by the difference between their expectancy for future improvement and their past expectancy for improvement.

B. Dependent variables. Two indicators of science teaching performance served as dependent variables.

1. Choice of science teaching methods: student emphasis, student-teacher cooperation, and teacher emphasis methods were the three performance variables measured by the Predicted Role Measure (Berger, 1971).

2. Persistence in teaching science: indicated by the teachers' allocation of time for teaching science as measured by the number of minutes of classroom time per week teachers estimate they spend teaching science. The guidelines of New York City and New York State (New York City Board of Education, 1965-1972; University of the State of New York, 1978) appear to suggest an approximate time allocation of 75 minutes per week in grades Kindgergarten through three and 150 minutes per week in grades four through six. In order to adjust for the differential in minimum time requirement between the upper and lower grades, this variable was expressed as an index: the decimal (quotient) that results when actual science teaching time is divided by required science teaching time as follows:

K-3 Time Allocation Index =

$$\frac{\text{Science lessons per week} \times \text{length of lesson} \times \text{estimated number of weeks}}{75 \text{ minutes per week}}$$

4-6 Time Allocation Index =

$$\frac{\text{Science lessons per week} \times \text{length of lesson} \times \text{estimated number of weeks}}{150 \text{ minutes per week}}$$

If teachers are following the guidelines suggested by New York City and New York State, the Index of Time Allocation should approximate 20, the actual number of weeks in the school term.

Methodology

Subjects

The subjects were 236 elementary school teachers, 210 females and 26 males, in four boroughs of New York City (excluding Staten Island) who volunteered to participate in the study. They had an average of 12.033 years of teaching experience and a mean age range of 41 through 50 years. The mean grade level taught was 3.093. The sample consisted of 141 teachers of grades kindergarten through three and 95 teachers of grades four through six. Elementary school teachers in bilingual programs or in classrooms where science was regularly taught by a specialist or cluster teacher were not included.

Instrumentation

The following four instruments were used:

1. The Teacher Background Information Instrument was a 16-item questionnaire used to measure several of the independent variables and one dependent variable, time allocation.

2. Science Teaching Situations, a modified version of an instrument developed by Ickes and Layden (1978), was used to measure causal attributions and causal dimensions which served as independent variables. This measure of

attributional style consisted of eight items. Each item contained a brief description of a hypothetical situation (for example, "Your class' science project is turning out very well") followed by four possible causes of the outcome ("you worked hard to prepare this project," "the project is easy to do," "the project is one for which you have considerable skill," or "you are lucky that several children have a special interest in this project"). Four situations described events that were successful and four described unsuccessful events, in a randomized order. For each situation, the four possible causes provided corresponded to the four causal attributions proposed by Weiner et al. (1971).

3. The Science Test of the Common Examinations of the National Teacher Examination, a secure 30-item test which was provided by the Educational Testing Service, Princeton, New Jersey. According to the Seventh Mental Measurement Yearbook, this instrument was designed to sample basic science concepts and generalizations which might be reasonably understood by any competent teacher. Separate advisory part scores were obtained for science. The reliability for the science scores ranges from .79 through .81, as obtained from Kuder-Richardson estimates.

4. The Predicted Role Measure (Berger, 1971) measures three categories of predicted teaching roles: Student emphasis role, student-teacher cooperation role, and teacher emphasis role. This instrument involves the use of a 16 mm. color film (Don't Tell Me, I'll Find Out, SCIS, 1968) and an accompanying booklet of items pertaining to science teaching situations in the film.

The reliability and two types of validity were determined for the PRM by Berger. The content validity was established by having eight judges rank the possible responses and achieving a Kendall coefficient of concordance greater than .90. Predictive validity was established by observing thirteen

teachers over a six-month period and calculating the ratio of teacher-observer agreements to the total number of observations made. This ratio had a range of .40 to 1.00, with a mean predictive validity of .74. A split-half measure of reliability of .84 was obtained by administering the PRM to a group of 23 graduate education students.

The Predicted Role Measure and three other instruments used in the present study were tested in a pilot study involving 61 teachers from one school district who were similar to the subjects. A Cronbach Alpha Reliability Coefficient of .701 was obtained for the PRM.

Design

The nonexperimental research of this investigation involved a posttest only design. Answers to the research questions posed were sought in the following ways. First, means and standard deviations were obtained for all the data collected. Question 1 called for *t* tests of mean score differences between causal attributions and between causal dimensions. Question 2 was examined by Pearson product-moment correlations between pairs of variables in the attributional model. Question 3 was studied by using stepwise multiple regression analyses followed by *F* tests for the significance of addition of variance increments by the predictors. The Statistical Package for the Social Sciences (SPSS) subprograms T-test, Pearson correlation, and Regression (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975), were used in the analyses. The alpha value for all tests was set at the .05 level.

Procedures

Subject Selection. In order to work with teachers in New York City, the investigator obtained the consent of the Board of Education, the United Federation of Teachers, and the superintendent of each community school district involved in the study. Subjects were recruited on a district-wide basis from

the roster of teachers listed on the organization sheet for each school. Before providing the organization sheet for the investigation, each building principal marked the classes that were taught by a science specialist or cluster teacher; or, which were conducted in a foreign language for more than one-half hour each day. Teachers of classes participating in these programs were not recruited for the study.

In the four participating school districts, 658 regular classroom teachers were found to be eligible and were contacted by mail. Of those contacted, 236 teachers, or 36% of those eligible, returned a response card and participated in the study. The teachers were compensated at the Union rate for participating in the after-school research sessions.

Administration of the Instruments. Arrangements for a suitable site and adequate seating for the subjects were made with the district personnel. The research site was a public school auditorium or classroom within each participating school district. Each session began promptly at 3:30 p.m. and terminated by 5:00 p.m. Except for the Science Test (ETS), the teachers were required to respond to every item in each instrument. The Science Test is a speeded examination which was administered in 15 minutes.

Results

The means and standard deviations for the variables used in the study are reported in Table 3.

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Place Table 3 about here

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Causal Attributions and Causal Dimensions

Causal Attributions. The first question addressed in the present

study sought to determine how teachers attribute the causes of their success or failure in science teaching. Significant differences were found in the teachers' ratings of the four causal attributions (ability, effort, task difficulty, and luck) in success and in failure (see Table 4). In success situations, the results indicate that the mean scores of the four causal

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attributions were all significantly different from each other. In success situations, the mean scores of each of the four causal attributions in the order of magnitude were as follows: Effort ($\bar{X}$ = 13.578), Ability ($\bar{X}$ = 10.795), Task Difficulty ($\bar{X}$ = 9.025), and Luck ($\bar{X}$ = 7.702) (see Table 3). Thus, in success situations, effort attributions had the highest mean scores, and luck attributions had the lowest.

For failure situations, results of the t tests indicate that the mean scores of the four causal attributions were also all significantly different from each other (see Table 4). In failure situations, the mean scores of the four causal attributions in order of magnitude were as follows: Task Difficulty ($\bar{X}$ = 9.429), Luck ($\bar{X}$ = 7.880), Effort ($\bar{X}$ = 6.663), and Ability ($\bar{X}$ = 5.459) (see Table 3). Thus, in failure situations, task difficulty attributions had the highest mean scores and ability attributions had the lowest.

t tests were also performed to determine if the mean scores of each of the four causal attributions were significantly different from each other for success and for failure situations. Results indicate that the ability attributions, the mean score for success situations is significantly higher than the mean score for failure situations (Success $\bar{X}$ = 10.795; Failure $\bar{X}$ = 5.459;

$t(234) = 18.99$, $p < .05$) (see Tables 3 and 5). For effort attributions, the

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mean score for success situations is significantly higher than the mean score of failure situations (Success $\bar{X} = 13.578$; Failure $\bar{X} = 6.663$; $t(234) = 22.45$ $p < .05$) (see Tables 3 and 5). However, results indicate that for task difficulty and luck attributions, the mean scores for success situations are not significantly different from the mean scores for failure situations.

Causal dimensions. The four causal attributions are classified along two dimensions, internality (internal minus external) and stability (stable minus unstable). Effort and ability attributions are internal to the person on the internality dimension while luck and task difficulty are external. On the stability dimension, attributions which vary over time, for example, effort and luck, are perceived as unstable, while task difficulty and ability which generally remain the same, are stable. Thus, effort is internal and unstable; ability is internal and stable; task difficulty is external and stable; and luck is external and unstable (Weiner, 1976).

T-tests were performed to determine if the mean scores of the causal dimensions were significantly different from each other for success and failure outcomes separately. Results indicate that in success situations, the mean scores for the internal attributions were significantly higher than the mean scores for the external attributions (internal success $\bar{X} = 24.194$; external success $\bar{X} = 16.580$; $t(234) = 20.58$, $p < .05$) (see Tables 3 and 6). In failure

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Place Table 6 about here

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situations, the mean scores for internal attributions were significantly lower than the mean scores for external attributions (internal failure $\bar{X}$ = 11.995; external failure $\bar{X}$ = 17.161; $t(234) = -10.67$, $p < .05$) (see Tables 3 and 6). Results also indicate that in success situations the mean scores for the stable attributions were significantly lower than the mean scores for the unstable attributions (stable success $\bar{X}$ = 19.661; unstable success $\bar{X}$ = 21.114; $t(234) = -5.00$, $p < .05$) (see Tables 3 and 6). However, in failure situations, the mean scores for the stable attributions were not significantly different from the mean scores for the unstable attributions (stable failure $\bar{X}$ = 14.750; unstable failure $\bar{X}$ = 14.406; $t(234) = 1.26$, $p > .05$, n.s.) (see Tables 3 and 6).

T-tests were also performed to determine if the mean scores of each of the four causal dimensions were significantly different from each other in success and failure situations. Results indicate that for internal attributions the mean score for success situations is significantly higher than the mean score for failure situations (success $\bar{X}$ = 24.194; failure $\bar{X}$ = 11.995; $t(234) = 23.81$, $p < .05$) (see Tables 3 and 7). For external attributions, the mean score

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for success situations is not significantly different from the mean score for failure situations (success $\bar{X}$ = 16.580; failure $\bar{X}$ = 17.161; $t(234) = 1.61$, $p > .05$, n.s.) (see Tables 3 and 7). Results also indicate that for stable attributions the mean scores for success situations is significantly higher than the mean scores for failure situations (success $\bar{X}$ = 19.661; failure $\bar{X}$ = 14.750; $t(234) = 13.76$, $p < .05$) (see Tables 3 and 7). For unstable attributions, the mean score for success attributions was also significantly higher than the mean score for failure attributions (success $\bar{X}$ = 21.114; failure $\bar{X}$ = 14.406; $t(234) = 18.96$,

$p < .05$) (see Tables 3 and 7). In addition, t-tests were also performed to determine if the means scores for internality and stability were significantly different from each other for success and failure situations. For internality, the mean score for success was significantly higher than the mean score for failure (success $\bar{X} = 7.614$; failure $\bar{X} = -5.165$; $t(234) = 19.53$, $p < .05$) (see Tables 3 and 7). For stability, the mean score for success was significantly lower than the mean score for failure (success $\bar{X} = -1.453$; failure $\bar{X} = .343$; $t(234) = -4.64$, $p < .05$) (see Tables 3 and 7).

The Attributional Model

The purpose of Question 2 was to determine if the relationship postulated by the Attributional Model of Achievement Motivation (Weiner, et al, 1978) can be used to explain science teaching performance in elementary school teachers. The attributional model predicts a series of relationships among antecedent factors, causal attributions, causal dimensions, causal effects, and performance (see Table 1). As indicated in Table 8, many significant but low-order correlations were obtained among these attributional variables.

Antecedents and causal attributions. Antecedents that were found to be associated with causal attributions were the teachers' perceptions of past success at teaching science, and their knowledge of science content. Teachers who scored higher on the standardized science test tended to attribute failure in science teaching to their lack of effort ($r = .150$) and to the difficulty of the task ($r = .110$). However, teachers who knew more science, did not tend to think that their success was caused by effort ($r = -.168$). Also, teachers who believed that their past science teaching was successful, preferred to attribute success to their ability ($r = .337$) and their effort ($r = .180$); but, they did not think that failure was caused by their lack of ability ($r = -.225$) or their lack of effort ($r = -.219$). However, the teachers' training in science

teaching methods was not significantly related to any of their causal attributions.

Causal effects. The attributional model indicates that causal attributions mediate between antecedents and causal effects. Nevertheless, low, but significant correlation coefficients were obtained between three antecedent factors and the teachers' enjoyment of science teaching. Teachers who expressed greater enjoyment for science teaching, tended to be those who believed that they were more successful in past teaching ($r = .453$); who knew more science content ($r = .127$); or who completed the greatest number of science teaching methods courses ($r=.185$). The fairly robust correlation obtained between perception of past success and enjoyment may result from the teachers' intervening attributions and dimensions as well as from emotions aroused in reaction to success as an outcome (Weiner, 1979). Also, the number of science teaching methods courses completed by the teachers appeared to be weakly related to their expectancy for improvement in science teaching ($r = -.109$). Thus, the teachers knowledge of science content and their perceptions of their past success at teaching science were related to their causal attributions and their enjoyment of science teaching. However, although the number of science teaching methods courses completed by the teachers was not related to any causal attributions, it was related to enjoyment and expectancy shift.

Teachers whose causal dimensions were more internal, tended to express greater enjoyment for science teaching in success situations ($r = .170$) and greater expectancy for improvement in science teaching in failure situations ($r = .127$). Furthermore, teachers whose causal dimensions were more stable also tended to express more enjoyment for science teaching ($r= .180$) and increased expectancy for improvement in science teaching ($r = .159$). Therefore, causal effects seem to be more closely aligned with success and failure outcomes than to causal dimensions.

Science teaching performance. Teachers who allocated more time to science in the classroom were also those who completed more science teaching methods courses (r = .178); who derived greater enjoyment from teaching science (r = .137); or who tended to be less internal (r = -.134) or more stable (r= .119) in failure situations. However, teachers with higher student emphasis scores on the PRM expected a greater improvement in their science teaching (r = .148); preferred stable attributions in failure situations (r = .123); or took fewer science content courses on the graduate level (r = -.124).

The Predictors of Science Teaching Performance

Question 3 sought to identify the predictors of science teaching method and time allocation. The results of the stepwise regression analysis of the 24 predictor variables and time allocation indicated that the number of science teaching methods courses completed by the teachers was the most significant predictor of the index of time allocation. Subsequent F tests for the significance of the variance increments by additional predictors indiciated that the addition of two other variables, attributes failure to lack of effort (negatively), and attributes success to ability, resulted in significant contributions to the prediction of time allocation. The process of selection was terminated beyond the third variable since the addition of further variables did not produce significant F values. A multiple correlation of .271 and a standard error of .423 were obtained. The final coefficient of multiple determination indicates that taken together, the first three predictors of the index of time allocation account for 7.3% of the criterion variance.

In order to determine the most efficient predictors of science teaching method the 24 predictor variables were entered into separate stepwise regression analyses with the three criterion variables measured by the PRM: student emphasis, student-teacher cooperation, and teacher emphasis methods.

The results of the regression analysis of the 24 predictor variables and the student emphasis method indicated that expectancy shift was the first significant predictor. Subsequent F tests for significance of the variance increments by additional predictors indicated that no additional variables contributed significantly to the prediction of student emphasis teaching. A multiple correlation of .148 and a standard error of .402 were obtained. The final coefficient of multiple determination indicates that expectancy shift accounts for 2.2% of the criterion variance. Stepwise regression analyses of the 24 predictor variables with the student-teacher cooperation and the teacher emphasis scores as criterion variables did not yield significant predictors.

Conclusions and Implications

Teachers' Attributional Styles

The results of the analysis of teachers' attributional styles in the present study support the conclusions that in successful teaching situations, teachers tend to make attributions to internal causes. In failure situations, teachers tend to make attributions to external causes. Therefore, the findings of the present study are generally consistent with other attributional research involving teachers (Beckman, 1970; Cooper & Burger, Note 3). Furthermore, the preference of teachers to make internal attributions also has its parallel in research measuring student attributions (Arkin & Maruyama, 1979; Bailey et al., 1975; Frieze et al., Note 2). However, in failure, students retain their preference for internal attributions while the teachers in the study strongly preferred external attributions. Further research is needed to help explain why students appear more willing than teachers, to accept responsibility for failure in an academic context.

Previous research also showed that the stability of students' causal attributions did not change with outcome. However, in the present study, the

teachers were less consistent than students in the stability of their causal attributions. In success, they preferred unstable attributions, but in failure the teachers had no significant preference in the stability of their attributions. The teachers' tendency to make unstable attributions in success situations results from their strong preference to attribute success to effort. However, Nicholls (1976) found that for tasks whose outcomes have long-range implications, it is more motivating to attribute success to ability than to effort.

These findings support the conclusion that elementary school teachers have distinct attributional styles for explaining success or failure in science teaching. Future investigations should attempt to determine those attributional styles which optimize science teaching performance.

The Attributional Model of Achievement Motivation

Antecedents and Causal Attributions. According to the attributional model (Weiner et al., 1978), antecedents are more closely related to causal attributions than to causal effects or to performance variables. The results of the present study show that two of the antecedents, perception of past science teaching success, and knowledge of science content, were related to the teachers' causal attributions and causal effects. Teachers who knew more science did not think that effort was the cause of their teaching success, but they blamed lack of effort for their unsuccessful teaching. Teachers with a greater knowledge of science content also expressed greater enjoyment for teaching science. However, knowledge of science content does not appear to be linked to expectancy shift or to performance variables.

Compared to knowledge of science content, the teachers' perceptions of the degree to which they were successful at past science teaching, appear to play a more prominent role throughout the attributional process. Teachers who

saw their past science teaching as successful, explained success with greater internality, and associated success with ability more than with effort. However, when explaining failure, teachers with high perceptions of past success avoided internal attributions and found ability attributions even more improbable than effort attributions. These findings contrast with the general attributional style of the teachers in the present study to prefer effort to ability attributions, but are consistent with Nicholl's (1976) data. Ickes and Layden (1978) found that the attributional style characteristic of high self-esteem subjects is to internalize success and to externalize or deny the probability of negative outcomes. However, they state that when used consistently or to extreme, this attributional assymetry can be maladaptive and can lead to the impairment of performance.

The finding that the number of science teaching methods courses completed by the teachers was significantly related to their causal effects (enjoyment and expectancy shift) and science teaching performance (time allocation and teaching method) but not to their causal attributions, is inconsistent with the attributional model. In the present study,other coursework completed by the teachers was found to relate to attributional cognitions. Therefore, it appears that the attributional model as proposed by Weiner et al. does not adequately explain the processes by which some antecedents are related to science teaching performance.

Causal dimensions and causal effects. It is not surprising that attributions along the internality dimension were more salient to the teachers since each antecedent measured was a characteristic of the teachers themselves. In successful teaching situations, greater internality and greater stability were associated with increased enjoyment. For unsuccessful teaching, more internality and more stability were associated with greater expectancy for improvement in science teaching. Therefore, the findings of the present study seem to

be in agreement with the attributional model that both internality and stability are related to affect; but, at odds with the theory's prognostication that expectancy shift will be related only to stability. A further problem is that the theoretical model does not explain why in the present study, positive outcomes are associated with affect, and negative outcomes are associated with expectancy shift. The obtained results appear to be supportive of other studies relating causal dimensions and causal effects in situations involving students (e.g., see Bailey et al., 1975; Frieze et al., Note 2; Nicholls, 1976). However, the inconsistencies in the relationship between expectancy and other attributional variables may result from the negative relationship obtained between enjoyment and expectancy shift.

Science teaching performance. The attributional model also postulates that causal effects influence performance. In the present study, enjoyment of science teaching was associated with increased allocation of time to science teaching. Furthermore, the teachers who were more favorable to student emphasis teaching were those who expected greater improvement in science teaching. Therefore, the results of product-moment correlation analyses just described, do not fully substantiate the attributional model. However, despite the inconsistencies and the very low level in the magnitude of the correlations obtained, the findings do appear to suggest that causal perceptions are at least as important as other factors in the teachers' background in contributing to choice and persistence of performance.

The Predictors of Science Teaching Performance

For science teaching methods, only one predictor, expectancy shift, was identified with the student emphasis role. No significant predictors of the student-teacher cooperation or the teacher emphasis methods were found.

The number of science teaching methods courses completed by the teachers and two causal attributions (success to ability, and negatively, failure to lack of effort) were identified as the three predictors of index of time allocation. However, these predictors accounted for only a very small fraction of the variance in science teaching performance. A possible interpretation of these results is that teachers' antecedent factors and causal cognitions are not important predictors of their own teaching performance. It appears that other factors in the teaching environment may be more closely associated with how science is taught than the teachers' preparation and willingness to teach science in the elementary school.

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Table 1

The Attributional Model of Achievement Motivation

Antecedents →	Causal Attributions →	Causal Dimensions →	Causal Effects →	Behavioral Consequences
Specific Information (social norms, past experience, patterns of outcome, past success, etc.)	Attributions Ability Effort Task Difficulty Luck Other (mood, fatigue, etc.)	Stability Internality	Expectancy shifts Affective reactions	Intensity, choice, and persistence of performance

Note. Modified from "Affect and Causal Ascriptions" by B. Weiner, D. Russell, and D. Lerman, in New Directions in Attribution Research (Vol. 2), J. H. Harvey, W. Ickes, and R. F. Kidd (Eds.). Copyright 1978 by Lawrence A. Erlbaum Associates, Hillsdale, New Jersey.

Table 2

Causal Dimensions and Causal Attributions

		Dimension	
		Internal	External
Dimension	Stable	Ability	Task Difficulty
	Unstable	Effort	Luck

Table 3

Means and Standard Deviations of the Predictor and Criterion Variables for the Sample of Elementary School Teachers (N = 236)

Variable	Mean	SD	n
Antecedents			
Years of teaching experience	12.033	6.059	236
Grade level now teaching	3.093	1.619	236
Number of high school science courses	4.038	2.124	236
Number of college science courses	3.142	3.444	232
Number of graduate science courses	0.270	0.825	233
Number of science education courses	1.659	1.520	235
Perception of past science teaching as successful	5.348[a]	1.706	235
Score on standardized science test	20.470[b]	3.741	236
Causal Attributions			
Attributes success to ability	10.795[c]	2.692	235
Attributes success to effort	13.578[c]	2.033	235
Attributes success to ease of task	9.025[c]	2.314	235
Attributes success to luck	7.702[c]	2.976	235
Attributes failure to ability	5.459[c]	3.006	235
Attributes failure to effort	6.663[c]	3.986	235
Attributes failure to task difficulty	9.429[c]	2.771	235
Attributes failure to luck	7.880[c]	2.875	235
Causal Dimensions			
Internal success (ability + effort)	24.194[d]	4.723	235
External success (task difficulty + luck)	16.580[d]	4.924	235
Internality for success (Internal - External)	7.614[e]	5.685	235
Internal failure (ability + effort)	11.995[d]	6.617	235
External failure (task difficulty + luck)	17.161[d]	5.406	235
Internality for failure (Internal - External)	- 5.165[e]	7.438	235
Stable success (ability + task difficulty)	19.661[d]	4.483	235
Unstable success (effort + luck)	21.118[d]	4.502	235
Stability for success (Stable - Unstable)	- 1.453[e]	4.468	235
Stable failure (ability + task difficulty)	14.750[d]	4.916	235
Unstable failure (effort + luck)	14.406[d]	5.472	235
Stability for failure (Stable - Unstable)	.343[e]	4.186	235
Causal Effects			
Enjoyment of science teaching	5.254[a]	1.646	236
Expected improvement in science teaching (shift)	0.451[f]	1.459	235
Criterion Variables			
Student emphasis teaching method	46.771[g]	8.993	236
Student-teacher cooperation method	48.402[g]	7.144	236
Teacher emphasis teaching method	36.961[g]	9.104	236
Index of time allocation for science teaching	12.053[h]	9.736	221

Note. Variations in n are caused by missing data.

[a]Possible range: 1 (low) through 8 (high)

[b]Possible raw score on NTE Science Test: 0 through 30

[c]Possible range: 0 (low) through 16 (high)

[d]Possible range: 0 (low) through 32 (high)

[e]Possible range: - 32 (low) through 32 (high)

[f]Possible range: -7 (greater failure) through 7 (greater success)

[g]Possible range: 0 through 72

[h]Score derived from the actual time teachers allocate per term divided by the time allocation per week suggested by New York City and State boards of education.

Table 4

t Tests for Differences Betwen Mean Scores of Teachers' Causal Attributions (*N* = 235)

Causal Attributions	Difference Between Means	Deviation of Difference	Error	*t* Value[a]
Success				
ability-effort	-2.783	2.830	0.308	-15.08*
ability-task	1.770	3.334	0.218	8.14*
ability-luck	3.093	4.101	0.268	11.56*
task-luck	1.323	3.036	0.198	6.68*
effort-task	4.553	3.050	0.199	22.89*
effort-luck	5.876	3.492	0.228	25.80*
Failure				
ability-effort	-1.204	3.122	0.204	- 5.91*
ability-task	-3.970	3.711	0.242	-16.40*
ability-luck	-2.421	3.835	0.250	- 9.68*
effort-luck	-1.217	4.770	0.311	- 3.91*
task-luck	1.548	2.803	0.183	8.47*
effort-task	-2.766	4.670	0.305	- 9.08*

[a] *df* = 234

*$p < .05$

Table 5

t Tests for Differences in Mean Scores of Teachers' Attributions for Success and Failure Outcomes (*N* = 235)

Causal Attributions	Difference Between Means	Deviation of Difference	Error	*t* Value[a]
Ability (success-failure)	5.336	4.307	0.281	18.99*
Effort (success-failure)	6.914	4.721	0.308	22.45*
Task difficulty (success-failure)	-0.404	3.417	0.223	- 1.81
Luck (success-failure)	-0.178	3.373	0.220	- 0.81

[a] *df* = 234

*$p < .05$

Table 6

t Tests for Differences Between Mean Scores of Teachers' Causal Dimensions (N = 235)

Causal Attributions	Difference Between Means	Deviation of Difference	Error	t Value[a]
Success				
internal-external	7.614	5.685	.370	0.58*
stable-unstable	-1.453	4.468	.291	- 5.00*
Failure				
internal-external	-5.165	7.438	.484	-10.67*
stable-unstable	.343	4.186	.272	1.26

[a] df = 234

*p < .05

Table 7

t Tests for Differences in Mean Scores of Teachers' Causal Dimensions for Success and Failure
(*N* = 235)

Causal Dimensions	Difference Between Means[a]	Deviation of Difference	Error	*t* Value[b]
Internal (success-failure)	12.119	7.872	.512	23.81*
External (success-failure)	- .580	5.518	.359	- 1.62
Stable (success-failure)	4.911	5.482	.357	13.76*
Unstable (success-failure)	6.708	5.435	.354	18.96*
Internality (success-failure)	12.779	10.055	.655	19.53*
Stability (success-failure)	- 1.796	5.953	.388	- 4.64*

[a]Mean score for success minus mean score for failure

[b]*df* = 234

*$p < .05$

Table 8

Significant Correlations of
Attributional Model Variables, N = 236 ($p < .05$)

Variables	Correlation Coefficient
Antecedents	
High school courses/Knowledge of content	.177
Teaching methods/Perception of success	.200
Antecedents and Causal Attributions	
High school courses/Success to ability	-.108
High school courses/ Success to effort	-.219
College courses/Success to ability	.129
Knowledge of content/Success to effort	-.168
Knowledge of content/Failure to lack of effort	.150
Knowledge of content/Failure to task difficulty	.110
Perception of success/Success to ability	.337
Perception of success/Success to effort	.180
Perception of success/Failure to low ability	-.225
Perception of success/Failure to lack of effort	-.219
Antecedents and Causal Effects	
Graduate courses/Expectancy shift	-.107
Teaching methods/Expectancy shift	-.109
Teaching methods/Enjoyment	.185
Knowledge of content/Enjoyment	.127
Perception of success/Enjoyment	.453
Antecedents and Science Teaching Performance	
Graduate courses/Student emphasis	-.124
Teaching Methods/Student-teacher cooperation	.115
Teaching Methods/Time allocation	.178
Perception of success/Student emphasis	.119
Causal Dimensions and Causal Effects	
Internality for success/Enjoyment	.170
Stability for success/Enjoyment	.183
Internality for failure/Expectancy shift	.127
Stability for failure/Expectancy shift	.159
Causal Dimensions and Science Teaching Performance	
Internality for failure/Time allocation	-.134
Stability for failure/Student emphasis	.123
Stability for failure/Time allocation	.119
Causal Effects and Science Teaching Performance	
Expectancy shift/Student emphasis	.148
Enjoyment/Time allocation	.137